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**INSTITUTION** Manpower Administration (DOL), Washington, D.C. U.S. Training and Employment Service.

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## ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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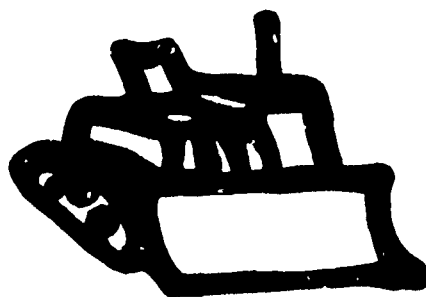
Development of USTES

APTITUDE TEST  
BATTERY FOR

**OPERATING  
ENGINEER**

(const.) II  
859 883

U.S DEPARTMENT OF LABOR  
Manpower Administration



ED 072046

Technical Report on Development of USTES Aptitude Test Battery

For . . . . .

Operating Engineer (const.) II 859.883

S-343R

(Developed in Cooperation with the  
California State Employment Service)

U. S. Department of Labor  
Manpower Administration

June 1970

## FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Development of USTES Aptitude Test Battery

For

Operating Engineer (const.) II 859.883-030

S-343R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery GATB norms for the occupation of Operating Engineer (const.) II 859.883-030. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	75
S - Spatial Aptitude	80
K - Motor Coordination	75

Research Summary

Sample:

92 men employed as Operating Engineer II 859.883-030 at various companies in the San Francisco Bay Area in California.

This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion:

Supervisory ratings.

Design:

Concurrent (test and criterion data were collected at approximately the same time).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity:

Phi Coefficient = .25 ( $P/2 < .01$ )

Effectiveness of Norms: Only 65% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 74% would have been good workers. Thirty-five percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 26% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	65%	74%
Poor Workers	35%	26%

SAMPLE DESCRIPTION

Size: N = 92

Occupation Status: Employed workers.

Work Setting: Workers were employed at various companies in the San Francisco Bay Area in California.

Employer Selection Requirements:

Education None required.

Previous Experience: None required.

Tests: None used.

Other: None

Principal Activities: The job duties for each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience: All workers in the final sample had at least one year job experience.

TABLE 2

Means (M), Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

	Mean	SD	Range	r
Age (years)	39.8	10.8	21-59	-.056
Education (years)	10.9	2.3	7-15	.200
Experience (months)	13.3	8.5	12-444	-.060

#### EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B were administered during the period of July, 1964 through November, 1964

#### CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as the tests were administered with a time interval of two weeks between the two ratings. The immediate supervisor rated each worker.

**Rating Scale:** An adaptation of Form SP-21 "Descriptive Rating Scale" was used. The scale (see Appendix) consists of nine items covering different aspects of job performance. Each item has five alternative responses corresponding to different degrees of job proficiency.

**Reliability:** A reliability coefficient of .82 was obtained between the initial ratings and the re-ratings, indicating a significant relationship. The final criterion score consists of the combined scores of the two ratings.

**Criterion Distribution:**

Possible Range:	18-90
Actual Range:	27-90
Mean:	64.6
Standard Deviation:	10.6

**Criterion Dichotomy:** The criterion distribution was dichotomized into low and high groups by placing 35% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 59.

### APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes S and K which do not have high correlations with the criterion, were considered for inclusion in the norms because the qualitative analysis indicated that the aptitudes might be important for the job duties and the sample had a relatively high mean score on Aptitude S and a relatively low standard deviation for Aptitude K. Aptitude N was considered for inclusion in the trial norms because G which qualified for consideration was eliminated from consideration in this reanalysis in order to minimize the verbal requirements of the battery. (In the composition of Aptitude G, arithmetic reasoning was the highest factor loading.) Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

#### Qualitative Analysis

(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Required to understand instructions and directions; to learn operational procedures and methods; to adapt work procedures to conform to safety rules; and to plan work in order to minimize unnecessary duplication of effort and loss of time.
S - Spatial Aptitude	Required to swing cranes to desired position; to visualize target point of crane bucket; to position machines accurately when picking up and delivering loads.
K - Motor Coordination	Required to coordinate eyes, hands, arms and feet rapidly and accurately to move pedals, switches, levers and other machine controls.
M - Manual Dexterity	Required in various phases of the operation of machines such as, setting controls and machine attachments and making adjustments on machines.



TABLE 4

Means (M), Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

N = 92

Aptitudes	Mean	SD	Range	r
G - General Learning Ability	98.4	17.8	62-162	.225*
V - Verbal Aptitude	98.3	16.5	63-166	.248*
N - Numerical Aptitude	90.7	17.2	43-138	.194
S - Spatial Aptitude	103.6	19.0	65-147	.158
P - Form Perception	88.9	19.3	39-137	.163
Q - Clerical Perception	96.1	16.5	65-185	.191
K - Motor Coordination	88.0	14.5	55-128	.172
F - Finger Dexterity	87.8	19.4	33-135	.134
M - Manual Dexterity	87.5	18.1	44-130	.095

\*Significant at the .05 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data:									
Important	X			X			X		X
Irrelevant									
Relatively High Mean	X	X		X					
Relatively Low Standard Dev.							X		
Significant Correlation with Criterion	X	X							
Aptitudes to be Considered for Trial Norms	G	V	N	S			K		

### DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of the degree to which trial norms consisting of various combinations of aptitudes V, N, S, and K at trial cutting scores were able to differentiate between the 65% of the sample considered to be good workers and the 35% of the sample considered to be poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about one-third of the sample; for two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of N-75, S-80, and K-75 provided optimum differentiation for the occupation of Operating Engineer (const.) II 859.883-030. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .25 (statistically significant at the .01 level).

TABLE 6

#### Concurrent Validity of Test Norms N-75, S-80 and K-75

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	14	46	60
Poor Workers	16	16	32
Total	30	62	92

Phi Coefficient = .25

Chi Square ( $\chi^2$ ) = 5.6

Significance Level =  $P/2 < .01$

#### DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-38 which is shown in Section II of the 1970 Manual for the General Aptitude Test Battery. A phi coefficient of .17 is obtained with the OAP-38 norms of N-80, S-85, K-80.

SP-21

A-P-P-E-N-D-I-X

DESCRIPTIVE RATING SCALE  
(For Aptitude Test Development Studies)

Score \_\_\_\_\_

RATING SCALE FOR \_\_\_\_\_  
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of Worker (print) \_\_\_\_\_  
(Last) (First)

Sex: Male \_\_\_\_\_ Female \_\_\_\_\_

Company Job Title: \_\_\_\_\_

How often do you see this worker in a work situation?

- ☐ See him at work all the time.
- ☐ See him at work several times a day.
- ☐ See him at work several times a week.
- ☐ Seldom see him in work situation.

How long have you worked with him?

- ☐ Under one month.
- ☐ One to two months.
- ☐ Three to five months.
- ☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

- ☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.
- ☐ 2. Capable of low work output. Can perform at a slow pace.
- ☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.
- ☐ 4. Capable of high work output. Can perform at a fast pace.
- ☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

- ☐ 1. Performance is inferior and almost never meets minimum quality standards.
- ☐ 2. The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.
- ☐ 3. Performance is acceptable but usually not superior in quality.
- ☐ 4. Performance is usually superior in quality.
- ☐ 5. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

- ☐ 1. Makes very many mistakes. Work needs constant checking.
- ☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.
- ☐ 3. Makes mistakes occasionally. Work needs only normal checking.
- ☐ 4. Makes few mistakes. Work seldom needs checking.
- ☐ 5. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

- ☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.
- ☐ 2. Has little knowledge. Knows enough to "get by."
- ☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.
- ☐ 4. Has broad knowledge. Knows enough to do good work.
- ☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

- ☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.
- ☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.
- ☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.
- ☐ 4. Usually does his job without difficulty. Well suited to this kind of work.
- ☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

- ☐ 1. Cannot perform different operations adequately.
- ☐ 2. Can perform a limited number of different operations efficiently.
- ☐ 3. Can perform several different operations with reasonable efficiency.
- ☐ 4. Can perform many different operations efficiently.
- ☐ 5. Can perform an unusually large variety of different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

- ☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.
- ☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.
- ☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.
- ☐ 4. Usually able to handle new situations. Needs help on only complex problems.
- ☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

- ☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.
- ☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.
- ☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.
- ☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.
- ☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and only these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

- ☐ 1. Would be better off without him. Performance usually not acceptable.
- ☐ 2. Of limited value to the organization. Performance somewhat inferior.
- ☐ 3. A fairly proficient worker. Performance generally acceptable.
- ☐ 4. A valuable worker. Performance usually superior.
- ☐ 5. An unusually competent worker. Performance almost always top notch.

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## FACT SHEET

### Job Title

Operating Engineer (const.) 859.883 -030

### Job Summary

Operates one or any combination of various power construction equipment pieces such as bulldozers, motor-graders, scrapers, power shovels, mobile or stationary concrete batching plants, draglines, and auxiliary construction machines such as conveyor belts, elevators, and drilling and pipe-laying equipment to excavate and grade earth and pour concrete. Manipulates hand and foot control wheels, levers, and pedals; notes guages, dials, and actions of controls and listens for trouble sounds; reports malfunctioning to oiler or construction mechanic. Receives special instructions by telephone or radio, and observes blowing of horns or other workman's signals to coordinate operations with those of other workers at the construction site.

### Work Performed

Comment: Work activities vary considerably depending upon number and kinds of machines operated and experience and skill of worker, but involve operation of three basic groups: earth movers, cranes, and stationary and mobile crushing and mixing plants. Typical work activities follow:

Batching Plant Operation: Operates a mobile, automated, pre-mix concrete batching plant for highway paving. Sets, adjusts, and monitors master console controls which activate or stop conveyor belts, tubes, weighing hoppers, electronic circuits, scales, dump-gates, water valves, loader spout, and tilt mixers, automatically drawing component materials from bins and silos; weighing, transporting, loading, mixing, and dumping according to pre-set cycles. Presses starter button activating all parts of system. Watches panel lights indicating various operations; jiggles toggle switch to open and close dumpgate mechanism freeing trapped materials. If malfunction persists, checks settings and adjusts switches to locate problem and calls for mechanic. Turns system to "manual" and moves knobs, levers, switches and buttons to regulate mixing, dumping, starting and stopping, or moves switch to "Recycle" automatically interlocking all operations into automatic cycling until switched to "hold" or "off". Watches control panel, materials on conveyor belts, and loading trucks or listens for horn signals of truck drivers pulling into place beneath mixers. **Changes** consistency of slurry when appearance indicates or instructions direct.

Bulldozer or Crane (Dragline) Operation: Receives foreman's instructions; waits for mechanic to start and warm engine; visually checks lever settings, guages, engine sounds or unnatural vibrations to detect malfunctioning; calls mechanic if manipulation of levers and controls does not free jamming or correct trouble. Manipulates hand levers and controls and foot pedals **singly or** in coordination with each other to drive equipment to work area. At end of day lowers blade and ripper of bulldozer to serve as brakes and sets transmission safety lock; lowers dragline bucket and secures brake; turns motor to neutral and leaves running.

Digs, moves, and drops material with dragline: Manipulates controls, hand levers and foot pedals singly or in coordination to raise or lower dragline bucket or move it right or left, determine angle of bucket teeth for loading or moving load, turn cab and boom, and swing boom to desired dumping point to allow gravity to drop load; visually checks operations and ~~gauges~~ adjustments to control operation of dragline.

Rips and prepares or moves earth with bulldozer: Pushes control to lower ripper to ground, shifts to low forward gear and drives tractor straight ahead governing speed by pressure on accelerator; brakes one track to change its speed and turns tractor in small arc; makes second pass over area adjacent to ripped strip. Maneuvers tractor so edge of blade slips under large rocks, lifts blade to dislodge rock and push it to edge of ripped area. Moves earth to crusher with blade: Maintains steady load in front of blade noting speed of motor as load increases or decreases and raises to drop or lowers to increase so blade maintains a steady load. Follows workman's signals to guide tractor as blade pushes dirt into crusher's mouth. Moves blade to float position, reverses tractor and backs from crusher.

#### Effectiveness of Norms

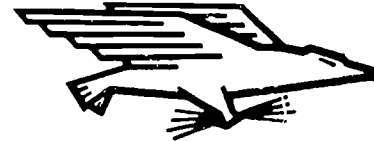
Only 65% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the S-343R norms, 74% would have been good workers. 35% of the non-test-selected workers used for this study were poor workers; if these workers had been test-selected with the S-343R norms, only 26% would have been poor workers.

#### Applicability of S-343 R Norms

The aptitude test battery is applicable to jobs which include a majority of duties described above.



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